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(54) Title: NONWOVEN FABRICS WITH TWO OR MORE FILAMENT CROSS SECTIONS

(57) Abstract: The subject invention concerns nonwoven fabrics containing filaments of at least two different cross sections. The subject invention further pertains to methods used to produce these fabrics. In an embodiment specifically exemplified herein, the nonwoven fabric of the subject invention is made of nylon.

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DESCRIPTION

NONWOVEN FABRICS WITH TWO OR MORE FILAMENT CROSS SECTIONS

Cross-Reference to Related Application

This application claims the benefit of provisional patent applications Serial No. 60/313,200, filed August 17, 2001 and Serial No. 60/331,812, filed November 20, 2001, which are hereby incorporated by reference in their entirety.

Field of Invention

This invention relates to new nonwoven fabrics made with two or more filament cross sections. The mixed filament cross sections give these new fabrics advantageous properties.

Background of Invention

Nonwoven fabrics and numerous uses thereof are well known to those skilled in the textiles art. Such fabrics can be prepared by forming a web of continuous filaments and/or staple fibers and bonding the fibers at points of fiber-to-fiber contact to provide a fabric of requisite strength. The term "bonded nonwoven fabric" is used herein to denote nonwoven fabrics wherein a major portion of the fiber-to-fiber bonding referred to is adhesive bonding accomplished via incorporation of adhesives in the web to "glue" fibers together or autogenous bonding such as obtained by heating the web or by the use of liquid or gaseous bonding agents (usually in conjunction with heating) to render the fibers cohesive or mechanical bonding, particularly autogenous bonding, the web may be subjected to mechanical compression to facilitate obtaining adequate bonding.

Properties of nonwoven fabrics are determined by several factors, including but not limited to, the method used to produce the fabrics, the polymer or polymer combinations used, the bonding method, the bond pattern, the fabrics, the structure of the fabric, the filament cross section, the filament denier (dpf) and the basis weight of the fabric. Nonwoven fabrics made with filaments with all round, all trilobal or all hollow cross sections are commonly found. These filament cross sections impart specific properties to the fabrics such as opacity or coverage, thickness, loft, strength, hand or softness, luster,

fiber surface area to facilitate coating, tensile strength, water absorption and other properties.

Spunbonded nonwoven fabrics formed of nylon, polyester, polypropylene, or other man-made polymers are widely used commercially for a number of purposes. Such fabrics exhibit excellent strength, coverage, hand and permeability properties and accordingly are desirable for use in construction fabrics, filtration material, mattress pads, mattress pad skirts, medical fabrics and furniture and bedding backing materials. The fabric can be produced via the well-known spunbonding process in which molten polymer is extruded through one or more spinnerets into filaments. Bicomponent or multicomponent spinning methods as described in U.S. Patent numbers 3,968,307; 4,052,146; 4,406,850; 4,424,257; 4,424,258; 4,830,904; 5,534,339; 5,783,503; 5,895,710; 6,074,590; and 6,207,276, incorporated by reference, can also be used to make multiconstituent filaments of different cross sections. The filaments are attenuated and drawn pneumatically and deposited onto a collection surface to form a web. The web is then bonded together to produce a strong, coherent fabric. Filament bonding is typically accomplished either thermally or chemically, i.e., autogenously. Thermal bonding is accomplished by compression of the web of filaments between the nip of a pair of cooperating heating calender rolls thereby setting the thickness. In autogenous bonding of nylon filaments, the web of filaments is transported to a chemical bonding station or "gashouse" which exposes the filaments to an activating agent (i.e., HC1) and water vapor. Water vapor enhances the penetration of the HC1 into the filaments and causes them to become tacky and thus amenable to bonding. Upon leaving the bonding station, the web passes between rolls which compress and bond the web thereby setting the thickness. Adequate bonding is necessary to minimize fabric fuzzing (i.e., the presence of unbonded filaments) and to impart good strength properties to the fabric. Autogenous bonding has been especially used in forming spunbonded nylon industrial fabrics. Mechanical compression normally sets the loft or thickness of fabrics with similar basis weights. It is common practice to increase thickness and strength by increasing the basis weight, or the mass per square area.

In many applications, the lightest nonwoven fabric that meets the product property requirements is used due to cost factors. A nonwoven fabric that would meet the requirements by yielding the desired properties at lighter basis weights would reduce costs. A process that makes such fabrics would also be beneficial.

Thickness or loft and coverage or opacity of nonwoven fabrics is normally determined by the basis weight. Increasing the basis weight adds cost due to the use of more raw materials. It is desirable to have increased thickness or coverage in some applications where these fabrics are used without increasing the basis weight. Thickness, coverage and strength can sometimes be affected by the filament cross section. Lighter weight fabrics with higher strength, loft or coverage would be more desirable and less costly.

Nonwoven fabrics are also used in a variety of coating applications. Coating materials will be captured and held more effectively onto a fabric that contains more fiber surface area. Fabrics that use less coating to effect the same desired results would be more cost effective and desirable.

Fabrics made with trilobal filaments tend to exhibit specular reflection. Although trilobal filaments have been effective in increasing coverage or opacity in fabrics, there is a need to reduce the specular reflection or "glittering" of these fabrics. A fabric with the coverage of a trilobal fabric with no glittering effect would also be advantageous.

Brief Summary

The subject invention concerns nonwoven fabrics containing filaments of at least two different cross sections. The subject invention further pertains to methods used to produce these fabrics. In an embodiment specifically exemplified herein, the nonwoven fabric of the subject invention is made of nylon. The non-woven fabric can be made by, for example, altering the filament cross section in a portion of the capillaries in the same spinneret or by using spinnerets with different filament cross sections on opposing sides of a spunbond beam.

The subject invention also provides advantageous processes for providing lighter fabrics that have the same properties as fabrics having higher basis weights. In a preferred embodiment, an improved nonwoven nylon fabric is produced by using filaments with at least two different cross sectional shapes. An important advantage of the process of the subject invention is that it provides a fabric with enhanced coverage and thickness, while maintaining excellent strength and softness characteristics of the nonwoven fabric.

In another embodiment, the nonwoven fabric can be produced by mechanically blending staple yarn with filaments of different cross sections into a web. This web is then

formed into a bonded nonwoven fabric using adhesives or mechanical methods such as, but not limited to, carding, needle punching, air laying, wet laying, hydroentangling, powder or adhesive bonding, air bonding, thermal bonding and chemical bonding.

In specific embodiments, the fabrics of the subject invention have filaments with two or more cross sections that are round, crescent, multilobal, oval, diamond or a cross section with voids (hollow filaments). The multilobal filaments have at least two lobes and, preferably, three or more lobes. In a preferred embodiment, the multilobal filaments are trilobal.

The use of multilobal filaments is particularly advantageous for maximizing coatings since these filaments have more surface area. The fabrics may have a dpf ranging from about 0.5 dpf to about 20 dpf.

Detailed Disclosure

In the following detailed description of the subject invention and its preferred embodiments, specific terms are used in describing the invention; however, these are used in a descriptive sense only and not for the purpose of limitation. It will be apparent to the skilled artisan having the benefit of the instant disclosure that the invention is susceptible to numerous variations and modifications within its spirit and scope.

The present invention concerns nonwoven fabrics with filaments of two or more different cross sections that provide properties better than fabrics with filaments of a single cross section. As used herein, reference to two or more cross sections refers to the shape of the cross sections. The subject invention further concerns methods used to produce these fabrics.

The fabrics of the subject invention have, for example, increased coverage or opacity compared to conventional nonwoven fabrics and have higher thickness while maintaining softness and strength at the same basis weight and dpf. In a preferred embodiment, round filaments are mixed with trilobal filaments to produce nonwoven fabrics. These fabrics have more opacity, stronger tensile properties and hold more coating material than fabrics made with only round cross section filaments because the trilobal filaments add strength by the way they pack in the fabric and add opacity by the way they reflect light. They also hold more coating material since trilobal filaments have more surface area.

The nonwoven fabrics of the subject invention have basis weights from 0.1 ounce per square yard up to 7 ounces per square yard. In a preferred embodiment, the weight of the fabric produced as described herein is between about 0.5 and about 2.5 ounces per square yard. In a specific embodiment, the fabric is about 1.15 ounces per square yard. The characteristics of the fabrics of the subject invention are achieved utilizing filaments having, for example, round, crescent, diamond, oval, hollow, and/or multilobal cross- sections.

In a preferred embodiment, the predominant fiber cross section is selected from the group consisting of round, multi-lobal, cresent, hollow, diamond and oval. As used herein, reference to the "predominant" cross section means that, by number, that cross section makes up a greater percentage of the filaments than any other single cross section. In a preferred embodiment, the predominant cross section comprises at least about 10% by number of the filaments. More preferably the filaments with the predominant cross section comprise at least 15%. The filament with the predominant cross section may comprise up to 95% of the filaments by number. Thus, the filaments with the predominant cross section may comprise from about 10% to about 95% of the filaments by number. The percentage can be any percentage between 10 and 95 and every such percentage between 10 and 95 is specifically contemplated by the subject matter.

The remaining filaments, in addition to the predominant filament, are preferably selected from the group consisting of round, multilobal, crescent, hollow, diamond and oval. As used herein, reference to hollow filaments contemplates one or more voids within the filaments.

The subject invention further concerns methods to produce these fabrics that contain filaments with at least two different cross sections. Any man-made (synthetic) polymer can be used, such as, but not limited to, polycaprolactum, polyamide, polyester, polyethylene, polypropylene, polylactic acid, nylon 10, nylon 11 and nylon 12. Blends and mixtures of man-made polymers can also be used. Conjugate spinning or multicomponenet spinning methods, known to those skilled in the art, can be employed to make filaments of at least two different polymer types with two or more different cross sections.

The fabrics can be produced by, for example, installing spinnerets with capillaries of different cross sections on different positions, sides or beams of a spunbond machine. Spinnerets with different capillary cross sections or capillary sizes within the same spinneret can also be used. The fabrics can also be produced by blending fiber with filaments of

different cross sections using carding methods and then using dispersing methods to produce a nonwoven web such as, but not limited to, air laying or wet laying methods, needle punching or hydoentangling. This web is then formed into a nonwoven fabric using adhesives or mechanical methods such as, but not limited to, powder or adhesive bonding, air bonding, thermal bonding or chemical bonding. Discrete bonds between the filaments may account for 5% to 50% of the area of the fabric and, more preferably, 16% to 24% of the area.

The fabrics of the subject invention can also be produced by extruding a plurality of continuous filaments, directing the filaments through an attenuation device, such as slots or jets, to draw the filaments, depositing the filaments onto a collection surface such that a web is formed, and bonding the filaments together either autogenously or thermally to form a coherent, strong fabric. In a specific embodiment, the fibers (filaments) of the fabric of the subject invention need not be crimpled. In a further specific embodiment the fibers are not melt blown. In a further specific embodiment, the filaments are continuous.

As would be appreciated by those skilled in the art, reference herein to the molecular orientation of a filament pertains to the alignment or arrangement of polymer chains in the filament. Molecular orientation is increased when filaments are drawn. In contrast to spunbond filaments, melt blown filaments are not drawn and therefore have little to no orientation of their polymer chains.

In a specific embodiment of the subject invention, fabrics with two or more filament cross sections can be made using a nylon spunbond method utilizing a slot drawing mechanism or attenuation jets. Typically, the nylon compound will be nylon 6, 6 and/or nylon 6; however, other man-made fibers from polymers such as, but not limited to, polyester, polypropylene, polyethylene or other polyamides or combinations of such can be used. Also, mixtures, blends or copolymers can be used as taught in U.S. Patents 5,431,986 and 5,913,993 both of which are incorporated herein by reference.

In one embodiment, polyethylene, polypropylene, and/or polyester can be added to the nylon material. This produces a softer feel and increases water repellency. In the case of polyethylene, the polyethylene should have a melt index between about 5 grams/10 min and about 200 grams/10 min and a density between about 0.85 grams/cc and about 1.1 grams/cc. The polyethylene can be added at a concentration of about 0.05% to about 20%.

Nylon filaments produced during the process of the subject invention may be bonded chemically, ultrasonically, or thermally. In one embodiment, HC1 gas and water vapor can be applied to achieve boding as described in U.S. Patent 3,853,659 incorporated herein by reference. In another embodiment, the filaments may be heated to, for example, between 180°C and about 250°C. Preferably, the filaments are heated to between about 200°C and 235°C.

It should be understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and the scope of the appended claims.

Example 1

Nonwoven fabric samples with two or more filament cross sections can be made using nylon 6,6 polymer by installing a spinneret with round capillaries on one side and a spinneret with trilobal capillaries on the other side of a dual spinning beam. Other combinations of cross sections can be used as shown in Table 1 below. The number of spinneret holes can be adjusted to produce fabrics with filaments that are less than 1.5 times larger than the smallest filaments in the fabric. Spinnerets with the same number of holes and the same spinneret throughput will yield the same dpf for all filaments. The nylon 6,6 polymer can be melted and extruded at a temperature of about 295°C. Filaments can then be attenuated and drawn pneumatically using aspirating jets or a slot device and deposited onto a laydown or forming box. The resulting webs can then be directed to a calender where about 20% of the surface area is bonded at discrete points at a temperature of about 216°C. It is expected that fabrics with some trilobal filaments will have higher opacity at the same basis weight than fabrics containing only round filaments.

Table 1. Possible Combinations of cross sections for Example 1	
Cross Section on One Side of Beam	Cross Section on Other Side of Beam
Round	Crescent
Round	Hollow
Round	Diamond
Round	Oval
Round	Multilobal
Trilobal	Hollow
Trilobal	Diamond
Trilobal	Oval
Trilobal	Multilobal
Hollow	Diamond
Hollow	Oval
Hollow	Multilobal
Dimaond	Oval
Diamond	Multilobal
Crescent	Trilobal
Crescent	Hollow
Crescent	Diamond
Crescent	Oval
Crescent	Multilobal
Oval	Multilobal

For comparison, commercially available fabrics under the trade name of "PBN-II", Type 30 and Type 31 by CEREX Advanced Fabrics, Inc. are made with round filaments in the entire web and trilobal filaments in the entire web, respectively.

Example 2

Nonwoven fabric samples can be made using nylon 6,6 polymer by installing a spinneret or spinnerets where more than 50% but less that 95% of the capillaries are of a

round cross section and the remaining are of a trilobal cross section. Placing the different cross sections in the same spinneret will yield the same dpf for all filaments.

The nylon 6,6 polymer can be melted and extruded at a temperature of about 295°C. Filaments can then be attenuated and drawn pneumatically using aspirating jets or a slot device and deposited onto a laydown or forming box. The resulting webs can then be directed to a calender where about 20% of the surface area is bonded at discrete points at a temperature of about 216°C.

Combinations of two different cross sections as shown in Table 1 can also be used to produce sample fabrics. Combinations of three or more filament cross sections can be created by adding one or more different cross sections in any possible combination to the items in Table 1 above. Filaments from each different cross section must comprise at least five or more percent of the total number of filaments. Filaments from any of the cross sections can make up the largest percentage of the total filaments in the web. For example, a fabric can be comprised of 40% hollow filaments, 25% round filaments, 25% trilobal filaments, 5% diamond filaments and 5% oval filaments.

Example 3

Nonwoven fabric samples can be made using nylon 6,6 or nylon 6 polymer or a combination of both as in example 1, except, the resulting web can be autogeneously bonded by directing the web to a chemical bonding station where the web filaments are bonded using HC1 gas and water vapor at a temperature around 39°C. The fabrics are produced by chemically bonding the filaments together in a gas house. The web is then subjected to a roll treatment in which the web is compacted and further bonded.

Example 4

Nonwoven fabric samples can be made using nylon 6,6 or nylon 6 polymer or a combination of both as in Example 2, except, the resulting web can be autogeneously bonded by directing the web to a chemical bonding station where the web filaments are bonded using HC1 gas and water vapor at a temperature around 39°C. The fabrics are produced by chemically bonding the filaments together in a gas house. The web is then subjected to a roll treatment in which the web is compacted and further bonded.

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Example 5

Nonwoven fabric samples can be made using polyester, polypropylene or polyethylene by installing spinnerets on respective sides of a spin beam as described in Example 1. The specific polymer must be melted and extruded at the appropriate temperature to achieve satisfactory spinning performance. Filaments can then be attenuated and drawn pneumatically using aspirating jets or a slot device and deposited onto a laydown or forming box. The resulting web can then be directed to a calender where about 20% of the surface area is bonded at discrete points at the appropriate temperature required to bond the web based on the polymer.

Example 6

Nonwoven fabric samples can be made as described in Examples 1 through 5 above using mixtures, blends or copolymers of man made polymers.

Example 7

Nonwoven fabric samples can be made as described in Examples 1 through 6 above using conjugate spinning or bicomponent spinning methods.

Example 8

A web of filaments can be produced with a blend of filaments with different cross sections in combinations listed in Table 1. Filaments with different cross sections can comprise at least one and, preferably, at least five or more percent of the total number of filaments. The web can then be formed into a bonded nonwoven fabric using adhesives or mechanical methods using the processes commonly referred to as carding, needle punching, wet laying, air laying, hydroentagling, powder or adhesive bonding, through air bonding, thermal bonding or chemical bonding.

Example 9

Fabrics can be produced as described in Examples 1 through 8 above with mixed filaments of different cross sections. Certain cross sections can cause spectral reflection which is not desirable in some applications. Small amounts of titanium dioxide can be added if spectral reflection is objectionable.

Example 10

Nonwoven fabric samples can be made using nylon 6,6 polymer by installing a spinneret or spinnerets where at least 14.5% of the capillaries are of a round cross section, 5% are of a trilobal cross section and the remaining capillaries are a combination of oval, multilobal, hollow, crescent or diamond cross sections. Placing the different cross sections in the same spinneret will yield the same dpf for all filaments. The nylon 6,6 polymer can be melted and extruded at a temperature of about 295°C. Filaments can then be attenuated and drawn pneumatically using aspirating jets or a slot device and deposited onto a lay down or forming box. The resulting webs can then be directed to a calender where about 20% of the surface area is bonded at discrete points at a temperature of about 216°C. Other percentages of different cross sections can be used to produce sample fabrics. Filaments from any of the cross sections can make up the largest percentage of the total filaments in the web. For example, a fabric can be comprised of 40% hollow filaments, 25% multilobal, 10% round filaments, 10% trilobal filaments, 2% diamond filaments, 8% crescent, and 5% oval filaments.

It should be understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application.

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In the Claims

We claim:

1. A nonwoven fabric comprising a plurality of polymeric filaments with molecular orientation bonded to one another to form a nonwoven web with a basis weight between 0.1 ounce per square yard and 7.0 ounces per square yard, wherein said fabric comprises filaments of two or more different cross sections.

2. The nonwoven fabric, according to claim 1, wherein the predominant filament comprises at least about 10% of the filaments by number.

3. The nonwoven fabric, according to claim 1, wherein the predominant filament makes up at between 25% and 75% of the filaments by number.

4. The nonwoven fabric, according to claim 1, wherein the predominant filament has a cross section selected from the group consisting of round, multilobal, crescent, hollow, diamond and oval.

5. The nonwoven fabric, according to claim 3, wherein the predominant filament has a round cross section.

6. The nonwoven fabric, according to claim 4, wherein said filaments with round cross sections make up between about 10% and about 95% of the filaments by number.

7. The nonwoven fabric, according to claim 1, wherein said fabric comprises round and multilobal filaments.

8. The nonwoven fabric, according to claim 7, wherein said multilobal filaments are trilobal.

9. The nonwoven fabric, according to claim 1, wherein the filaments are made from polyamide, polycaprolactum, nylon 11, nylon 12 or nylon copolymers or a combination of these nylon polymers.

10. The nonwoven fabric, according to claim 1, wherein the filaments are made from nylon; polyester, acrylic, polyethylene, polypropylene, polylactic acid, polyvinyl alcohol polymers or a combination of these polymers.

11. The nonwoven fabric, according to claim 1, wherein the filaments are conjugate fibers made from nylon, polyester, acrylic, polyethylene, polypropylene, polylactic acid, polyvinyl alcohol polymers or a combination of these polymers.

12. The nonwoven fabric, according to claim 1, that is thicker than a nonwoven fabric consisting of round cross section filaments of the same denier and same basis weight.

13. The nonwoven fabric, according to claim 1, that is stronger than a nonwoven fabric consisting of round cross section filaments of the same denier and same basis weight.

14. The nonwoven fabric, according to claim 1, that is softer than a nonwoven fabric consisting of round cross section filaments of the same denier and same basis weight.

15. The nonwoven fabric, according to claim 1, that is more opaque than a nonwoven fabric consisting of round cross section filaments of the same denier and same basis weight.

16. The nonwoven fabric, according to claim 1, that has enhanced wicking performance compared to a nonwoven fabric consisting of round cross section filaments of the same denier and same basis weight.

17. The nonwoven fabric, according to claim 1, that has enhanced insulating performance compared to a nonwoven fabric comprised of round cross section filaments of the same denier and same basis weight.

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18. The nonwoven fabric, according to claim 1, wherein the filaments of said spunbonded fabric are autogenously bonded to one another at discrete points throughout the fabric.

19. The nonwoven fabric, according to claim 1, wherein 5% to 50% of the fabric area is bonded to one another at discrete points throughout the fabric.

20. The nonwoven fabric, according to claim 19, wherein 16% to 24% of the fabric area is bonded to one another at discrete points throughout the fabric.

21. A method of producing a nonwoven fabric comprising filaments with molecular orientation and wherein the filaments have two or more different cross sections; wherein said method comprises using spinnerets that have different cross sections to form filaments and directing a plurality of said filaments onto a collection surface to form a web.

22. The method, according to claim 21, wherein discrete bond sites are formed in the fabric by heating the web of filaments in discrete areas and forming thermal bonds.

23. The method, according to claim 22, wherein the discrete thermal bonds comprise 5% to 50% of the fabric area.

24. The method, according to claim 23, wherein the discrete thermal bonds comprise 16% to 24% of the fabric area.

25. The method, according to claim 21, wherein a multiplicity of discrete bond sites is formed in the fabric by forming bonds autogenously at the filament cross over points.

26. The method, according to claim 25, wherein the filaments are nylon and the step of forming bonds autogenously at the filament cross over points comprises contacting the filaments with gas which will render the filaments cohesive and form bonds at their cross over points.

27. The method, according to claim 21, wherein the same spinneret forms filaments with two or more different cross sections.

28. The method, according to claim 21, wherein different spinnerets are used to form filaments with two or more different cross sections.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 899 785 A (BARAVIAN JEAN ET AL) 4 May 1999 (1999-05-04) the whole document ---	1,4,9, 10, 12-18, 21,22, 25,27,29
X	EP 0 381 206 A (DU PONT) 8 August 1990 (1990-08-08)	1,4
A	the whole document ---	2,3,5-8, 12-21,25
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 02, 28 February 1997 (1997-02-28) & JP 08 260323 A (UNITIKA LTD), 8 October 1996 (1996-10-08) abstract ---	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
10 January 2003	24/01/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	V Beurden-Hopkins, S

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 02/27182

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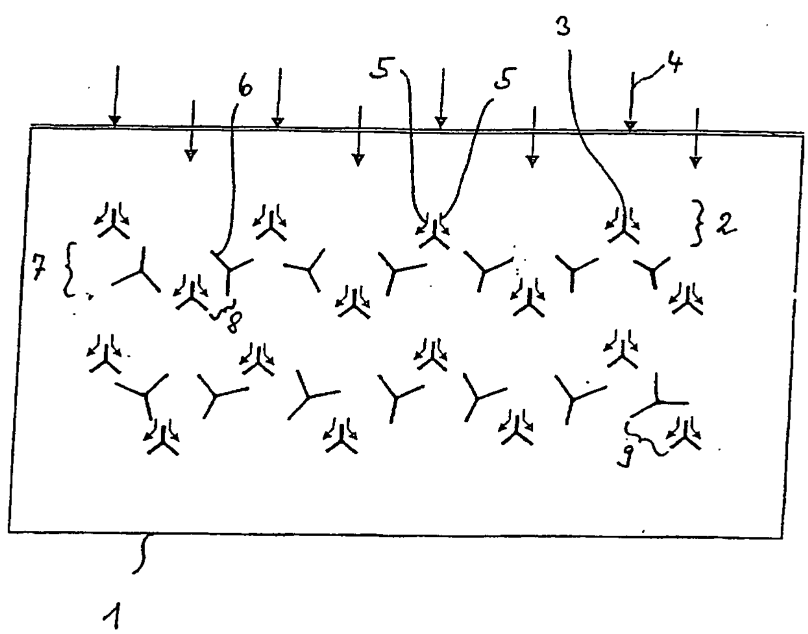
(54) Title: NON-ROUND SPINNERET PLATE HOLE



(57) Abstract: The present invention concerns a spinneret plate (1) for manufacturing a nonwoven fabric, having multiple non-round holes, which are similar to trilobal or multiarmed holes (3) in particular, for polymer flow outlet to produce filaments, in which identical holes are positioned in rows offset relative to one another. At least a first row (2) has a positional arrangement of the holes that differs from the positional arrangement of a second row (7) of rows through rotation of the holes.

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NON-ROUND SPINNERET PLATE HOLE

The present invention relates to a spinneret plate for manufacturing a nonwoven fabric, having multiple non-round holes, which are similar to trilobal or multiarmed holes in particular, for polymer flow outlet to produce filaments, identical holes being positioned in rows offset with respect to one another.

Methods are known for producing filaments having a non-round cross section in the manufacture of nonwoven fabrics. This cross section may be, for example, trilobal, i.e. the cross section has three arms that are connected to each other at a centre. It is also possible to create, for example, star-shaped or other non-round cross sections. For example, a method is known from German Patent No. DE 36 341 46 A1 for creating a nonwoven, fibrous fabric using a spinneret plate in which the spinneret plate is furnished with "bilobal" holes. These bilobal holes each consist of two circular apertures which are connected with one another by a connecting element. German Patent No. DE 36 341 46 A1 further describes other slot geometries that are known in the related art and used in spinneret plates. These may have the form of slit-shaped, triangular, half-moon, or also T-shaped apertures in spinneret plates.

The object of the present invention is to ensure that non-round filaments having uniform properties are produced that may be used in manufacturing a nonwoven fabric.

This object is achieved with a spinneret for manufacturing a nonwoven fabric having multiple non-round holes, which are similar to trilobal or multiarmed holes in particular, and which have the features according to Claim 1, with a spin packet having the features according to Claim 7, and with a method for cooling and/or stretching a molten polymer material

having the features of Claim 11. Further advantageous configurations and refinements are indicated in the respective subordinate claims.

A spinneret plate for manufacturing a nonwoven fabric has multiple non-round holes, which are similar to trilobal or multiarmed holes, for polymer flow outlet to produce filaments. The spinneret plate has identical holes in rows that are offset with respect to each other. A first row has a positional arrangement of the holes which differs from the positional arrangement of a second row of holes through rotation of the holes. A uniformly shaped, directed blowing of the polymer material exiting each hole may be achieved by rotation of the holes. Blowing is effected particularly using a cooling gas, which is upon impinging for example perpendicularly on the polymer material being discharged. The cooling gas may also be upon impinging at an inclined angle, thereby causing the polymer material to be stretched during production of the filaments. An approximately similar blowing, for example with a cooling gas through holes that are arranged one behind the other, may be achieved by rotating the holes.

According to an improvement, rows of holes may be placed in more than just one different positional arrangement by rotation of the holes. Instead, the holes may also be arranged offset with respect to each other. This means that for example holes in a first row as seen from the blowing direction do not obscure holes in a second row that are arranged behind them. Instead, the holes of at least this second row are also surrounded by cooling gas that has not yet been diverted by other polymer material.

One refinement provides that the spinneret plate has different types of holes. The facility to rotate the holes means that blowing may be kept uniform even if the holes have differing cross sections. This in turn influences the properties of the

filaments. Rotation may be synchronised with the cross section of the holes, blowing conditions, flow rate of the polymer and other parameters so that the properties of the filaments may be adjusted in a targeted manner. This may be used for example to modify the longitudinal or transverse mechanical strength of the filaments, their opacity and other properties.

Another provision envisages that the spinneret plate is divided into at least two regions, and that the first region and the second region are each furnished with two or more rows of identical holes. In particular, one region only has holes of a certain dimensioning and/or geometry. The regions are preferably separated from each other, for example by a gap that extends between the holes of different regions. In particular, the separation between holes of a region is the same size or smaller than the gap between two regions. This allows a number of additional possibilities. On the one hand, a certain separation, and thus also a certain bundling of filaments may be obtained, which bundling is reflected subsequently for example in the nonwoven fabric. On the other hand, a larger separation between different regions enables processes to take place in this gap that would be disruptive for the filament manufacturing process if they were performed in other areas of the spinneret plate. For example, the gap may be used as a mixing zone for different cooling flows. In particular, the holes between the regions may be rotated and preferably also offset with respect to each other. An improvement provides that the first region has a positional arrangement of the holes which is rotated by 180° relative to the positional arrangement of the holes in the second region. This symmetrical inversion of the positional arrangement of the holes with respect to each other enables blowing to take place in uniform manner, especially if the spinneret plate is blown with a cooling gas from two sides. In this way, it is possible to ensure that comparable rows of different regions are blown in at least an

approximately similar manner, so that filaments are also formed similarly.

A further provision of the invention envisages that a spin packet including at least a first and a second spinneret plate is provided, the first and second spinneret plates being positioned neighboring one another in the spin packet. The first and the second spinneret plates each have non-round holes, the holes in the first spinneret plate being positioned rotated in relation to the holes in the second spinneret plate. The advantage of this arrangement is that the construction of spinneret plates for a spin packet is the same. However, then the spinneret plates are installed, they are offset with respect to one another. As a result, it is possible to proceed preferably with manufacturing equipment and manufacturing jigs that already exist.

The spin packet preferably has an installation protection cooperating with the respective spinneret plates. This installation protection ensures that the spinneret plates may also be installed only in the positions to which they are allocated. This installation protection may be provided for example using tongue and groove connections between the spinneret plates and the spin packet. This modular construction of the spin packet also enables different spinneret plates to be used in combination. This in turn allows of a wide variety of variants in terms of the geometries, rotations and also offsets of the holes with respect to each other in the spin packet.

According to a further refinement, multiple spinneret plates are positioned neighboring one another in the spin packet, each of the spinneret plates having only a certain number of rows of holes. For example, one spinneret plate has 15 or fewer, particularly 10, preferably 5 and fewer holes. This enables the positional arrangement of the holes for example to be rotated a

little farther from one spinneret plate to the next, for example. It is then also possible for correspondingly suitable positional arrangements of the holes and therewith also angles of rotation to be set for different blowing behaviors of the spinneret plates without the need to produce entirely new spinneret plates. Moreover, with the arrangement of different spinneret plates in the spin packet, it is possible use combinations of different types of holes depending on the intended use of the nonwoven fabric to be manufactured. Thus for example the first and/or the second spinneret plate may each include various types of holes. In this way, a wide variety of different holes may be used in combination in one spin packet. This may then be implemented advantageously if various properties, such as the fabric layer's insulating behaviour, the liquid absorbency of the nonwoven fabric to be produced, or even a liquid-repellent property of the fabric, are to be set in a specific manner by means of the different cross sections, including the use of filament cross sections appropriate to the purpose.

A further provision of the invention envisages a method of cooling and/or stretching a molten polymer material during spunbonded fabric manufacturing. The polymer material is discharged from multiple non-round holes, which are at least similar to trilobal or multiarmed holes, in at least one spinneret plate. In so doing, the polymer material forms polymer filaments. A first gas flow from a first side and a second gas flow from a second side are each upon impinging on the polymer material as it exits the holes. The first gas flow, at least when it is upon impinging on a first row of polymer filaments, is guided along the shape thereof in mirror image to the guidance of the second gas flow when that is upon impinging on a first row of polymer filaments in the same location. This mirror imaging of the blowing from two separate, especially opposing holes causes the formation of the polymer filaments to become more uniform, so that the properties of the polymer

filaments and thus also of the nonwoven fabric also become more homogenous. In addition, this also particularly means for example that the gas flows used may be applied to the polymer filaments at speeds different than those of conventional, opposing gas flows used in producing spunbonded fabrics.

An improvement provides that the first cooling stream and the second cooling stream are guided in mirror image to one another over multiple rows of polymer filaments. To this end, the holes used are preferably constructed as mirror images of each other, and also having the same dimensioning. Preferably, the first and the second gas flows are each deflected at least in part from a first polymer filament row onto a neighboring second polymer filament row. For this purpose rows of holes that are arranged one behind the other are preferably offset with respect to each other. For example, holes may at least partially overlap each other when viewed in the direction of flow. The shape and disposition of the hole may also cause the exiting polymer material to assume a filament cross section that causes the blown gas flow to change direction. A gas flow is preferably deflected by a first polymer filament row onto a subsequent polymer filament row in such manner that the second polymer filament row is also subjected to a directed blowing action.

According to a further provision of the invention, a device for manufacturing spunbonded fabric is created. The device for manufacturing spunbonded fabric has a first and a second gas supply for cooling and/or stretching filaments. The first and the second gas supplies are preferably positioned so that they operate parallel to one another. Preferably, they have at least partially diametrically opposed escape openings. Additionally, the device for manufacturing spunbonded fabric has multiple identical spinneret holes, which have a non-round cross-section. A first region of identically aligned spinneret holes discharges in a blowing region of a first gas fluid escape

opening. A second region of identically aligned spinneret holes discharges in a blowing region of the second escape opening of the second gas supply. The first and the second regions are spatially separated from one another, the spinneret holes of the first region being rotated relative to the spinneret holes of the second region such that a polymer material that is discharged from the spinneret holes is subjected to identical blowing in the first region and in the second region.

The filaments produced in this way may then be deposited for example on a travelling screen and processed further. The uniform blowing from at least two sides on holes that are each aligned identically with respect to the direction of blowing further enables for example the gas fluid to be used as a carrier medium. Additives in the gaseous or liquid or solid phase may be mixed into the carrier medium. These additives may modify at least the surface of the filaments.

Further advantageous configurations and refinements will be explained in detail in the following drawing. The features represented and described therein may be combined with the features described in the foregoing to create yet other configurations of the invention, without the need to specify these individually. In the drawing:

Fig.1 Shows a first spinneret plate with non-round holes,

Fig.2 Shows a second spinneret plate with non-round holes,

Fig.3 Shows a cross section of Fig.2 with a hole as shown in Fig.2,

Fig.4 Is a plan view of spin packet with two spinneret plates with non-round holes installed in the spin packet and

Fig.5 Is a diagrammatic view of a device for manufacturing spunbonded fabric.

Fig.1 shows a first spinneret plate 1 with a first row 2 of non-round holes 3. Non-round holes 3 have a trilobal cross section. First row 2 is blown by a gas flow, which is indicated by arrows. Non-round holes with trilobal cross-section are arranged in the first row 2 such that one leg extends approximately parallel to the direction of blowing of gas flow 4. In this way, the flow of gas 4 that is upon impinging on a polymer material is split and deflected along the other legs of non-round hole 3. This deflection particularly takes place in such manner that partial flows 5 of gas flow 4 are upon impinging on subsequent second holes 6 of a second row 7 which is arranged behind the first. First non-round holes 3 and the second holes 6 may have the same shape, as shown, but they may also have differing shapes. They may also differ in their dimensions. Second holes 6 in second row 7 are set at an inclined angle relative to those in the first row 2. As is indicated in Fig.1, the rotation in a row may be uniform for all holes, or it may be varied for different holes. Partial streams 5 are preferably either directly upon impinging on a leg of the holes or are in turn directed approximately parallel to a leg of the subsequent hole, before they are deflected again. In particular, one arrangement of the holes in the first row 2 and the second row 7 may be configured so that turbulence is created at a specific location in gas flow 4 upon impinging on the polymer filaments above spinneret plate 1. In addition, the holes of various rows may be arranged such that a kind of jet effect is produced between neighboring holes. For example, neighboring holes are arranged so that a narrowing 8 is produced, which causes partial flow 5 to accelerate. On the other hand, the option also exists of providing a widening 9. This widening would cause a reduction in the flow speed of partial flow 5. It is also possible to arrange identically

aligned holes in rows one behind the other, without interposing a row of holes that is arranged differently.

Fig.2 shows a second spinneret plate 10 with a first region 11 and a second region 12. First region 11 is furnished with trilobal holes 13. Second region 12 has identical trilobal holes 13, but the latter are arranged in a mirror image of those in first region 11. A gap 14 is located between first region 11 and second region 12. This gap 14 preferably does not include any holes from which polymer material is discharged to form filaments. However, suction orifices 15 and/or gas flow baffles 16 for example may be situated in the gap. While the gas flow may be drawn inside a spunbonded device via suction orifices 15, the gas flow is deflected by gas flow baffles 16 in such a way that it is redirected towards the point at which the polymer material is discharged from trilobal holes 13.

Fig.3 shows an enlarged trilobal hole 13 according to Fig.2. Trilobal hole 13 has three arms, a first arm 17, a second arm 18 and a third arm 19. The three arms 17, 18, 19 are preferably arranged with an angle of 120° relative to each of the other two. However, various angle ratios may also be set for the trilobal hole 13. For example, a first angle 20 may be smaller than a second angle 21 and a third angle 22. Preferably however, all trilobal holes 13, not only in one region of the spinneret plate, are aligned in the same direction. Rather, the first arm 17 points in the direction from which the cooling air is flowing, as shown in Fig.3. This enables a uniform flow of cooling air into the interstitial areas between the fibres, uniform fiber cooling and prevents turbulence or eddies or other disturbances between fibres from different rows. Arms 17, 18, 19 may also be different in length. For example, all three arms 17, 18, 19 be of different lengths, or even only one arm may be longer or shorter. First arm 17 is preferably shorter than second arm 18 and third arm 19. Because the polymer material exiting from first arm 17 is exposed to a cooling air

flow on both sides, the temperature falls more quickly there than for the polymer material that exits trilobal hole 13 along second arm 18 and third arm 19. To compensate for this unequal cooling and stretching behaviour, arm 17 for example may be shortened. Moreover, differing geometry of the trilobal hole with respect to the blowing provides the capability to carry out a specific rotation of the filaments produced. For example, the cooling air flow may have the effect of a kind of rotation. It is also possible to achieve a crimping effect on the filaments or fibres thus produced by varying the stretching and/or cooling effects of arms 17, 18, 19.

Fig. 4 shows a spin packet 23 with a third spinneret plate 24 and a fourth spinneret plate 25. Both spinneret plates are blown in parallel, but from opposite directions. A gap 26 is also provided between the two spinneret plates 24, 25. Gap 26 preferably creates a separation from 1 to 100 mm, particularly from 5 to 25 mm. Such a separation may also be present in the between different regions of spinneret plate, as shown for example in Fig.1. Rows of spinneret holes in spinneret plates 24, 25 themselves are preferably separated by a distance that is smaller than gap 26. A spinneret plate or region of a spinneret plate also preferably has 5 to 15 rows of spinneret holes 27.

Fig.5 is a diagrammatic view of a device 28 for manufacturing spunbonded fabric. Device 28 for manufacturing spunbonded fabric 28 includes a single spinneret plate 29. Single spinneret plate 29 includes trilobal holes -not further shown- through which the first polymer filaments 30 and second polymer filaments 31 are discharged. For the sake of clarity, the figure shows only one of each polymer filament, highly enlarged. The trilobal holes in single spinneret plate 29 are arranged so that first polymer filaments 30 are discharged from single spinneret plate 29 with a leg aligned parallel to a first cooling air flow 32. First cooling air flow 32 is

indicated by the arrows. The cooling air flow may pass directly below single spinneret plate 29, but may equally well be at a distance therefrom or over an area. At the same time, cooling air flow 32 may pass at right angles to the outflow direction of first polymer filaments 30, or it may also be at an angle inclined thereto. While first polymer filaments 30 are arranged in a first area, second polymer filaments 31 are arranged in a second, separate area. Second polymer filaments 31 are blown by a second cooling air flow 33, and optionally stretched. Second cooling air flow 33 is blown parallel to the first cooling air flow 32. Due to the arrangement according to which the trilobal holes in the first region are mirrored by the trilobal holes in the second region, the polymer filaments produced are cooled more uniformly, and as a consequence the properties of the nonwoven fabric produced from the polymer filaments are also more uniform.

The nonwoven fabric produced using these spinneret plates or such spinneret plates installed in a spin packet is preferably used in sanitary products, household articles, in nonwoven fabrics for technical applications, such as in filter wadding, in the construction industry, in medical applications, for clothing, particularly protective clothing or similar applications. The nonwoven fabric may consist of a single ply or multiple plies, may include different fabric types, may have one or more coating films. The filaments produced may be made from a polyolefin, a polyolefin mixture, for example as a bicomaterial also made from polypropylene and polyethylene. Other geometries may also be used besides the trilobal holes described, for example "c", "u", "v", "L", "*" or more complex shaped holes. One or more different geometry types may be used, and these may be used at least partly in combination with each other and/or separated entirely from each other in separable regions.

Claims

1. A spinneret plate (1), for manufacturing a nonwoven fabric, having multiple non-round (3) holes, which are similar to trilobal or multiarmed holes in particular, for polymer flow outlet to produce filaments, in which identical holes (3) being positioned in rows offset to one another, characterized in that at least one first row (2) has a positional arrangement of the holes which differs from the positional arrangement of a second row (7) of rows through rotation of the holes.

2. The spinneret plate (1) according to Claim 1, characterized in that the spinneret plate (1) has at least two different types of holes (3).

3. The spinneret plate (1) according to Claim 1 or 2, characterized in that the spinneret plate (1) is divided into at least two regions, in which the first region (11) and the second region (12) each having two or more rows of identical holes (3).

4. The spinneret plate (1) according to Claim 3, characterized in that the first region (11) has a positional arrangement of the holes (3) which is rotated by 180° in relation to the positional arrangement of the holes (3) in the second region (12).

5. The spinneret plate (1) according to one of the preceding claims, characterized in that

at least the first region (11) and the second region (12) are separated from one another by a gap (14).

6. The spinneret plate (1) according to Claim 5, characterized in that
the gap (14) is the same size or larger than a distance between two rows of identical holes (3).

7. A spin packet (23) having at least a first spinneret plate (24) and a second spinneret plate (25), in which the first spinneret plate (24) and the second spinneret plate (25) being positioned neighboring one another in the spin packet (23) and the first spinneret plate (24) and the second spinneret plate (25) each having non-round holes, in which the holes in the first spinneret plate (24) being positioned rotated in relation to the holes in the second spinneret plate (25).

8. The spin packet (23) according to Claim 7, characterized in that
the holes in the first spinneret plate (24) have the same dimensioning as the holes of the second spinneret plate (25).

9. The spin packet (23) according to Claim 7 or 8, characterized in that
the first and/or the second spinneret plate (24, 25) have different types of holes.

10. A spunbonded fabric manufacturing device (28) having a first and a second gas supply for cooling and/or stretching filaments, in which the first and the second gas supplies being positioned parallel to one another and having at least partially diametrically opposite escape openings, having multiple identical spinneret holes, which have a non-round cross-section, a first region of

identically aligned spinneret holes discharging in a blowing region of the first escape opening and a second region of identically aligned spinneret holes discharging in a blowing region of the second escape opening and the first and the second regions being spatially separated from one another, the spinneret holes of the first region being rotated in relation to the spinneret holes of the second region in such a way that a polymer material discharged from the spinneret holes is subjected to identical blowing in the first region and in the second region.

11. A method of cooling and/or stretching a molten polymer material during spunbonded fabric manufacturing, the polymer material being discharged from multiple non-round holes (3), which are similar to trilobal or multiarmed holes in particular, in at least one spinneret plate (1) and forming polymer filaments, a first gas flow upon impinging from a first side and a second gas flow upon impinging from a second side on the polymer material coming out of the holes, characterized in that the first gas flow, at least upon impinging on a first row of polymer filaments, is guided along their shape in mirror image in comparison to guiding of the second gas flow upon impinging on a first row of polymer filaments at its location.

12. The method according to Claim 11, characterized in that the first gas flow and the second gas flow are guided in mirror image to one another over multiple rows of polymer filaments.

13. The method according to Claim 11 or 12, characterized in that

both gas flows are at least partially deflected from a first polymer filament row onto a neighboring second polymer filament row.

14. The method according to Claim 13,
characterized in that
both gas flows are deflected onto a second polymer filament row, which follows the first polymer filament row in a blowing direction.

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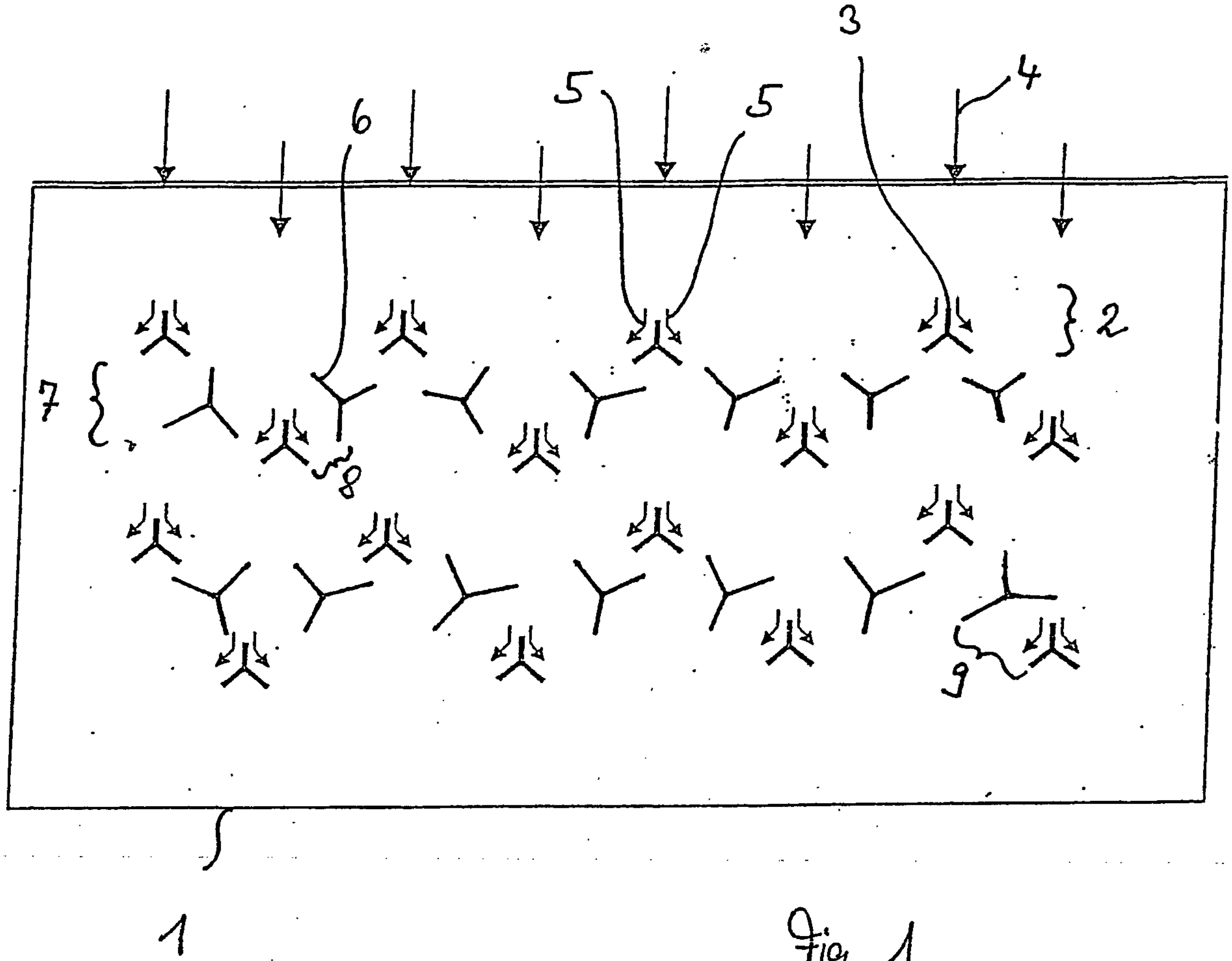

Fig. 1

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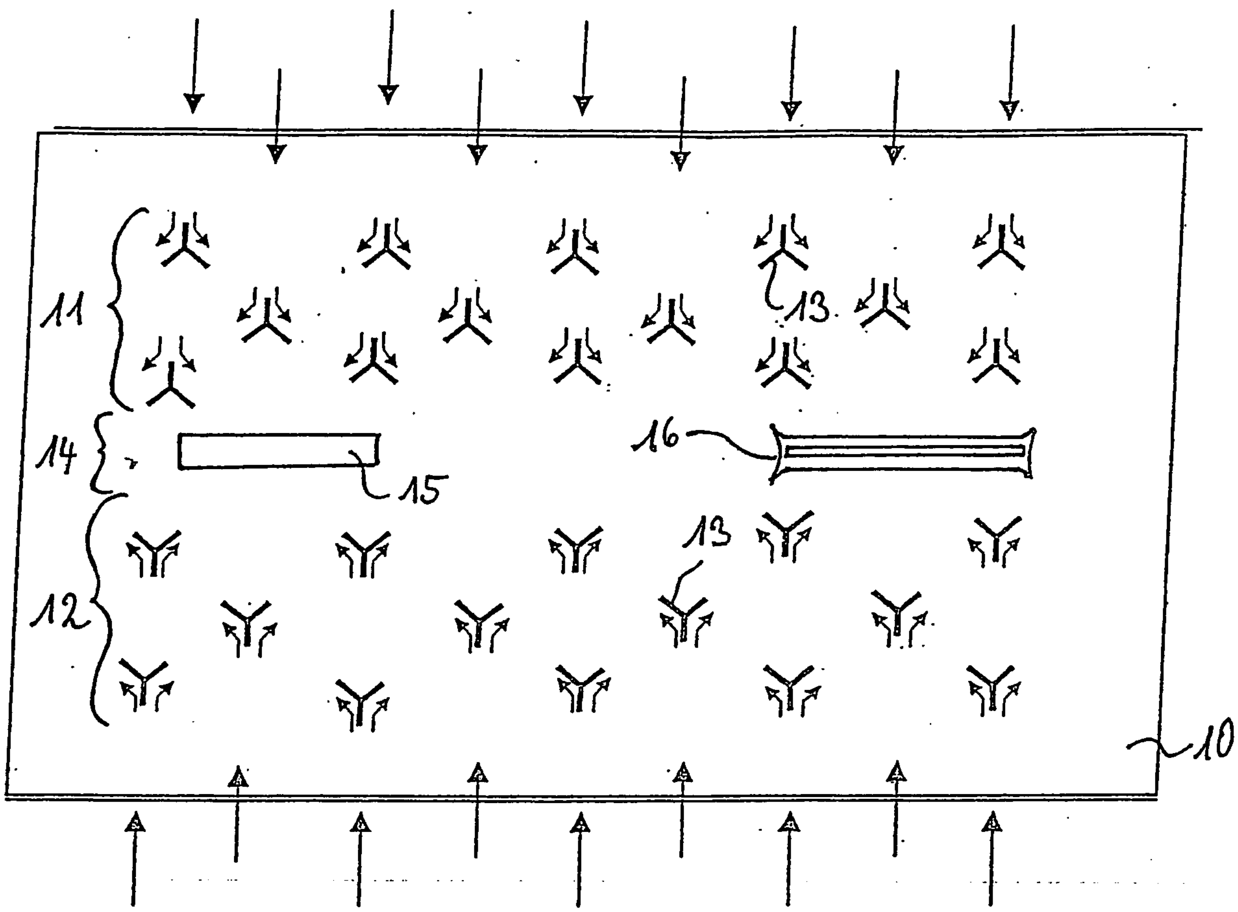

Fig. 2

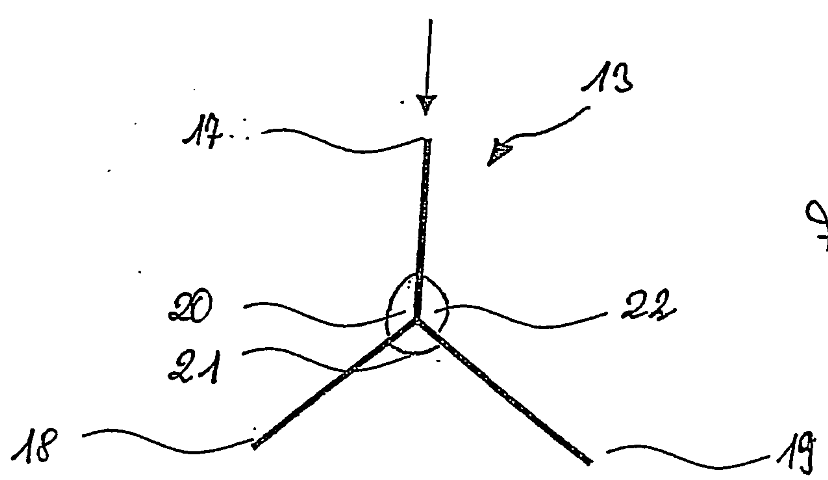

Fig. 3

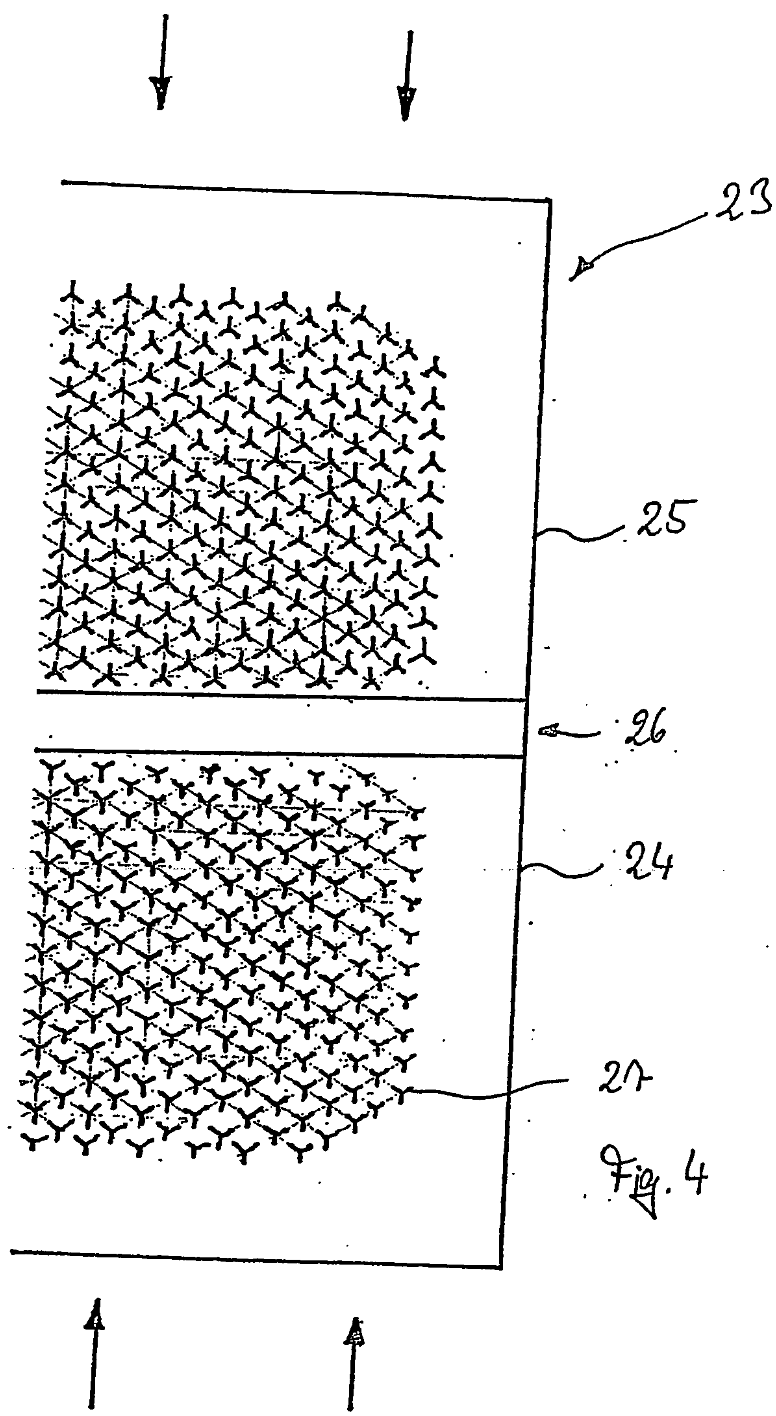

Fig. 4

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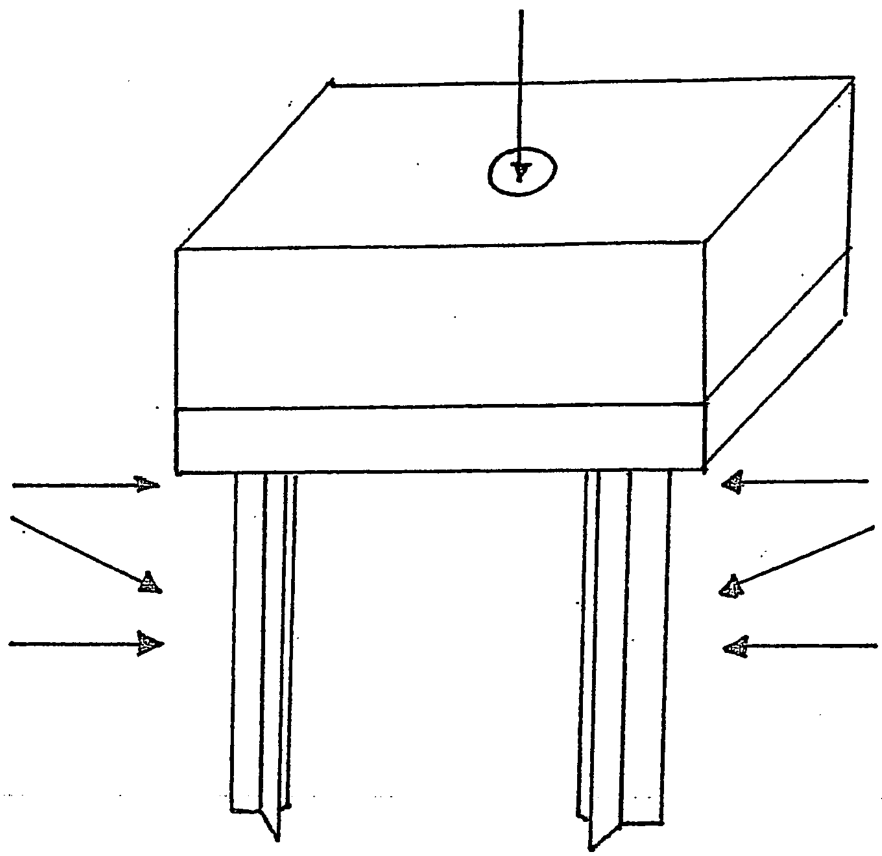

Fig. 5

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